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AIRPLANE SPRAYING EXPERIMENTS TO CONTROL THE RED-HEADED PINE SAWFLY

1947

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May 10, 1948

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During the 1947 season, between 25,000 and 50,000 acres of pine plantations in Illinois, Michigan and Wisconsin were defoliated to varying degrees by the red-headed pine sawfly, Neodiprion lecontei (Fitch). Experimental airplane spray applications of DDT oil sprays were made on 749 acres of the Shawnee National Forest, Illinois, in June and early July and on 200 acres in early November. Excellent control was obtained in some instances with dosages of both 1 pound and 1/2 pound of DDT in 1 gallon of spray per acre. However, the results were not uniformly good. Details of the tests conducted and the results obtained are given later in this report.

PREVIOUS SPRAY TESTS

On July 31, 1946, an oil solution and a suspension of DDT were applied by plane on the Manistee National Forest, Michigan, on an experimental basis to control the red-headed pine sawfly. The oil spray contained approximately 1.7 pounds of DDT per gallon and was applied at the rate of 1 gallon per acre. Practically 100 percent kill of the larvae occurred where the trees were in the open, but little kill was obtained where there was a heavy hardwood overstory. Considerable difficulty was encountered in dispensing the suspension and control was unsatisfactory.

DDT aerial sprays were successfully used to control this sawfly in other parts of the country prior to 1947. It was found that the insect was readily killed with 1 pound of DDT per acre.

PURPOSE OF 1947 SPRAY TESTS

The primary purpose of the 1947 tests with the first brood larvae was to determine the minimum effective dosage that could be used. It was also desirable to learn whether the volume of spray applied could be safely reduced below 1 gallon per acre. Furthermore, because of the variations in the amount of hardwood cover in many plantations, it was desirable to ascertain how much cover would be effectively penetrated by the spray.

The third brood tests in the fall were quite limited because of insufficient infestation due to only a partial brood. These tests were made primarily to determine the influence of different degrees of atomization, and the height of the plane above the trees when the spray was dispensed, on the effectiveness of the spray.

EXPERIMENTAL SPRAY PLOTS

Both the first and third brood tests were made in shortleaf pine plantations on the Shawnee National Forest. The trees were between 5 and 12 feet tall. In the first brood spraying the plots varied from 80 to 300 acres in size, even though composed of more than one plantation because of the irregular shape and size of the plantations. However, in the third brood spraying only 5 plots were sprayed, and each of these contained approximately 40 acres.

SPRAY FORMULATIONS AND DOSAGES

An oil solution formula was used in all of the 1947 tests. It consisted of 40 ounces (1-1/4 quarts) of FD 544 C (Socony Vacuum Co.) auxiliary solvent per pound of DDT (Technical Grade), diluted with No. 2 fuel oil to make the desired concentration in the final spray. Dosages of 1, 1/2 and 1/4 pound of DDT, at a rate of 1 gallon and 1/2 gallon of spray per acre, were used in the third brood spray tests.

MIXING AND LOADING SPRAYS

A Bean Power Sprayer with a 450-gallon tank was used to mix the sprays used in the first brood spray tests. The desired quantity of solvent was first pumped into the tank and with the agitators running, the DDT was added. Agitation of the mixture was continued for about 20 minutes, or until all the DDT was dissolved. Then the desired quantity of fuel oil was added. The sprays were mixed at a field depot several miles from the airport, transferred to drums and trucked to the airport as needed. A small centrifugal pump was used to pump the spray from the drums into the tank in the plane.

The spray used in the third brood spray tests was mixed in a large tank, equipped with agitators and a pump, on a 1-1/2 ton truck owned by the commercial firm that contracted to apply the spray. The plane was loaded directly from the mixing truck.

APPLICATION OF SPRAYS

Pilots

Pilot F. R. Walker of the Forest Insect Laboratory at Beltsville, Md., made the spray applications on the first brood plots, sprayed between June 14 and July 2. He is experienced in aerial forest spraying and exceptionally conscientious. Walker's performance on this spray job was marked by the same skill and efficiency that had characterized his earlier work. The third brood spray applications, made on October 4 and 6, were applied by Air-Spray, Incorporated, Chicago, Illinois, under contract with the U. S. Forest Service. Their pilot, A. L. Aldrich, who operated the plane earlier in the season, sprayed 2,400 acres of spittlebug infested plantations on the Nicolet National Forest in northern Wisconsin. The sawfly infested experimental plots sprayed on November 4th and 6th were covered in a commendable manner.

Spray Planes

The plane used in the June-July experimental spray applications was one of the Beltsville Laboratory's Stearman NBS-4 biplanes (NR-2002). It was a trainer type, equipped with a standard 200 horse-power Continental engine and converted for spray work. The spray apparatus consisted of a tank installation (capacity 70 gallons) mounted in the front cockpit, a 1-inch nozzle boom suspended beneath the lower wing, and a wind-driven centrifugal pump mounted beneath the fuselage on the landing gear struts. An adjustable pressure relief valve mounted on the discharge side of the pump was used to regulate pressure, and agitation of the spray liquid was provided by a bypass line carrying the overflow from this valve back into the tank. The boom was

fitted with commercial spray nozzles (B-5 manufactured by Spraying Systems Company) having a 1/8-inch orifice and producing a hollow cone spray pattern. These nozzles were attached at more or less uniform intervals, with short nipples and elbows so that the spray was released slightly below and to the rear of the boom. At each nozzle a spring loaded check valve was installed to prevent drooling of the liquid from the boom after the spray was shut off. The rate of flow required to apply a dosage of 1 gallon per acre on a swath 2 chains wide at normal operating speed (85 mph) was 22.8 gallons per minute. Calibration flights with the pressure regulated to 25 pounds per square inch showed the number of nozzles needed for this output to be 30 with this particular equipment. For the 1/2-gallon per acre treatments, half this number of nozzles was used, while the 2-gallon per acre treatment was secured by double coverage at the 1 gallon per acre rate.

The plane used in the October spray tests, as described by J. M. Davis, who represented the Beltsville, Maryland, Forest Insect Laboratory in this work, was a conventional N3N biplane trainer converted for spraying. The engine had been altered by enlarging the cylinders and pistons and supercharging so that it developed 315 horsepower. The spray equipment consisted of an 80 gallon tank mounted in the front cockpit, a 3/4-inch nozzle boom suspended beneath the lower wing and an externally mounted wind-driven gear pump connected to the control valve by 5/8-inch o.d. aluminum tubing. With the control valve in the "off" position the insecticide was shunted back into the bottom of the tank. No relief valve was provided, and all feed lines were of the 5/8-inch o.d. tubing size. The boom was tapped at uniform intervals to receive fittings with 1/4-inch pipe threads. Nozzles used for most of the work were B-5 (manufactured by Spraying Systems Co.) having a 1/8-inch orifice and producing a hollow cone spray pattern. A springloaded check valve, made by the same company, was inserted between the boom and each nozzle, making the nozzle aperture about 3 inches below the boom when directed to the rear. Also tried on one plot were 30 V-jet nozzles of a size that gave a flow rate comparable to the B-5. No calibrations with oil were made, but calibration flights with cold water showed the flow rate to be 17.9 gallons per minute with 30 B-5 nozzles and 16.3 gallons per minute with 20 such nozzles. For a 1-gallon per acre treatment, swath widths used for these two flow rates were 104 and 93 feet respectively. Performance of this equipment was satisfactory as far as could be observed, except that the check valves occasionally clogged with undissolved DDT residue, and distribution of the spray was then somewhat irregular. The DDT residue was due to an error in mixing the spray which resulted in the use of only 32 ounces of auxiliary solvent per pound, instead of the usual 40 ounches.

Markers

During the June-July spraying, wherever practical, markers were used at both ends of each swath, although the shape of some of the plots was such that only one flagman could be used, and others were so irregular that the swaths could not be marked. Some of the areas treated were distinguishable by natural features; others were so overgrown with black locust and scrub growth that it was necessary to mark the corners with white cloths draped over low trees. Because of the overgrowth, some difficulty was experienced in aligning the spray runs satisfactorily. In most cases flight lines were parallel to the longest plot dimension, but in some instances the terrain made this impossible. The plots sprayed in November were located in separate blocks

distinguished by natural features so that the marking of boundaries was unnecessary. Each of the swaths was designated by an orange flag fastened to a heavy wire frame and attached to a 10 foot bamboo pole. The marker was held at the center of the swath and the pilot instructed to fly over it.

Base of Operations

Operations were based at an airfield 3 miles northeast of Harrisburg, Illinois. The field was sufficiently large and had two sod runways, but it was somewhat rough. During take-offs with heavy loads the effects of former plowing in the area were noticeable. The plots were all within a radius of 20 miles of the airfield. Before spray flights were begun, the pilot reconnoitered the areas from the air, usually a day or two ahead of the scheduled treatment, to determine the location and shape of the plots. Aerial photographs were used to some extent in this work, but because they had been taken some time previously, before the hardwood growth had overtopped the pine, they were not as useful as photos of more recent origin would have been. They were employed to advantage, however, in determining how the plots should be flown and marked.

RESULTS

The results obtained in the first brood tests are summarized in Table 1.

TABLE 1.

SPRAY EXPERIMENTS WITH DDT-OIL SOLUTIONS TO CONTROL THE RED-HEADED PINE SAWFLY IN SHORTLEAF PINE PLANTATIONS ON THE SHAWNEE NATIONAL FOREST, JUNE 14 TO JULY 2, 1947 (749 ACRES TREATED)

Area No.	Acreage	Date Sprayed	Dosage: Lbs. DDT per Acre	Dosage: Gals. Spray per Acre	Results: No. infested trees examined	Results: Percent trees free of larvae 1/	Remarks
49	75	6/14 4:15 a.m.	1/2	1	80	100	Ideal weather conditions; foliage wet but not dripping; no rain for following 5 days; larvae in 1st to 4th instars; only surviving larvae noted were under hardwood overstory.
50	64	6/14 6:00 a.m.	1/4	1	140	85	Ideal weather conditions during first flight, gusty breeze during second flight; foliage dry; no rain for following 5 days; no kill on 30 trees under hardwood overstory.
51	95	6/16	1	1	95	68	Ideal weather conditions, no wind; foliage wet and dripping due to heavy fog; no rain for following 3 days.
55	80	6/16	1/2	1	30	83	Ideal weather conditions, no wind; foliage wet but not dripping; no rain for following 3 days.
56	80	6/16	1	1/2	60	22	Gusty wind, considerable drift; foliage dry.
36B	76	6/27	1/2	1	200	1	Slight breeze; foliage wet and dripping; rained from 10:00 to 12:00 a.m. and from 2:00 to 5:00 p.m.; larvae in 5th and 6th instars.
36A	72	6/28	1	1	160	6	Rainstorm at dawn but other than a slight breeze, weather conditions were good; foliage wet and dripping; light rain the following afternoon.
57) 58A) 62)	20 17 21	6/30	1/2	1	40	38	Slight breeze, some spray drift; foliage wet and dripping; heavy rain in afternoon.
59) 60) 61) 63)	52 40 35 21	6/30	1/2	1	40	5	Brisk breeze when last spraying was done; foliage dry; heavy rain in afternoon.

1/ The percentages of larvae killed were probably higher than the percentages of trees free of larvae.

The above data show that this sawfly can be effectively controlled with dosages of 1/2 pound and 1 pound of DDT in 1 gallon of spray per acre. However, extremely erratic results were obtained. Some of these might be attributed to unfavorable weather conditions at the time of and immediately following application.

Table 2 summarizes the results obtained in the five 40-acre plots sprayed by Pilot Aldrich in November. These tests were all made at a dosage of 1 pound of DDT in 1 gallon of spray per acre.

TABLE 2.

SPRAY TESTS WITH DDT-OIL SOLUTION* TO CONTROL THE RED-HEADED PINE SAWFLY IN FIVE 40-ACRE PLOTS IN SHORTLEAF PINE PLANTATIONS ON THE SHAWNEE NATIONAL FOREST, NOVEMBER 4 AND 6, 1947

Plot No.	No. and kind of nozzles	Elevation flown	Date Sprayed	Miscellaneous information	Results: No. trees examined	Results: Percent control	Remarks
1	20 (B-5)	50 ft.	11/4/47 7:00 a.m.	Very little wind; foliage wet; rain at 12:30 p.m.; temperature 55° F.	(11/7) 80	87	All larvae on 70 of the 80 trees were dead and intact colonies were present on only 2 trees.
					(11/11) 80	100	No living larvae found on the 80 currently infested trees examined.
2	20 (B-5)	50 ft.	11/6/47	Slight wind; temperature 54° F.; difficulties encountered due to plugging of nozzles.	(11/11) 14	100	Infestation was light, consequently only 14 currently infested trees were checked.
3	30 (B-5)	50 ft.	11/4/47 8:45 a.m.	Wind 4-5 m.p.h.; foliage dry; rain at 12:30 p.m.; temperature 55° F.	(11/7) 100	83	All larvae on 83 of the 100 trees were dead and intact colonies were present on only 4 trees.
					(11/11) 50	100	No living larvae found on the 50 trees examined.
4	30 (V-jets) Same flow capacity as B-5.	50 ft.	11/6/47	Wind 12-15 m.p.h. Cones indicated poor coverage due to high wind and plugging of nozzles. Resprayed with ½% solution near dark that evening.	(11/11) 38	97	Thirty-eight trees with larvae on them were tagged at time of spraying; 37 of these had no larvae present and there were only a few scattered larvae on the other tree.
5	30 (B-5)	10 ft.	11/4/47 10/15 a.m.	Very little wind part of time but it was about 10 m.p.h. part of time; foliage dry; rain 12:30 p.m., temperature 50° F.	(11/7) 80	91	All larvae on 73 of the 80 trees were dead and intact colonies were present on only 1 tree.

*Dosage: 1 pound in 1 gallon of spray per acre, except in plot 4 as indicated.

DuPont oil red dye was dissolved in the spray applied in November and the quantity of spray deposited on each plot was determined by means of a sampling system devised by Davis in which filter paper cones, each with a recovery area of about 30 square inches, were used. The cones were distributed at approximately 15 foot intervals across the plots along a line perpendicular to the lines of flight. Upon completion of the field applications the cones were shipped to the Beltsville Laboratory where the dyed spray deposited on the filter paper was extracted, and the quantity determined colorimetrically. The results obtained are summarized below:

Sta. No. (Filter Paper Cone)	Plot Number				
	1	2	3	4	5
		Pounds per Acre			
1	0.79	1.17	0.60	0.45	0.50
2	.32	1.17	.41	.72	.85
3	.08	1.18	.39	.28	1.35
4	.00	.86	.32	.00	.24
5	.13	1.02	.58	.84	.65
6	1.12	.39	.99	.00	.42
7	.99	1.05	.94	.00	.71
8	1.85	1.02	.55	.00	.21
9	.52	1.12	.34	.00	.00
10	.97	.58	.41	.00	.00
11	2.12	.58	.52	.00	.18
12	1.10	.22	.60	.00	.41
13	.97	1.39	.52	.05	.08
14	.34	1.84	.39	.00	.79
15	1.26	1.49	.94	.00	1.25
16	.68	.00	.15	.00	.81
17	.93		.89	.00	1.15
18	.73		1.31		1.54
19	.00		1.05		.19
20	.00		1.29		.31
21	.84		1.10		1.57
22	1.36		.60		.19
23	.45		.31		.31
24	.50		.08		.29
25			1.18		.94
26			.32		1.33
27			.06		.84
28			.19		1.02
Means	.75± .57	.94± .47	.60± .36		.68± .44

Davis states that the variations in deposit on plots 1, 2, 3 and 5 are to be expected in any aerial spraying, and are probably due to a number of factors such as minor errors in flight pattern, differences in altitude of the plane, small changes in air speed and changes in wind. There was a 12-15 m.p.h. wind at the time plot 4 was sprayed and it was evident from ground observations and the cones that very little of the spray descended properly. Therefore, it was resprayed on the same day with a 1/2-pound dosage.

Excellent control was obtained in all 5 plots. This means that there was adequate coverage over a swath 100 feet wide when the spray was applied at elevations of 10 and 50 feet above the trees and adequate coverage when B-5 nozzles were used at approximately 15 and 25 pound pressures. The V-jet nozzles also gave effective coverage. These results, in general, confirm the findings of detailed aerial spray studies being conducted at Beltsville, Maryland, in which it has been demonstrated that in upwind flights (1) differences in altitude of spray release, between 25 and 200 feet above the ground, do not materially change the coverage and effectiveness of the spray; and (2) both B-5 and V-jet nozzles, at the same flow rate, produce somewhat comparable results.

CONCLUSIONS

It is apparent that further tests with aerial sprays should be made with this insect due to the erratic results obtained. However, since in some instances excellent kill was obtained with dosages of 1/2 and 1 pound of DDT in 1 gallon of spray per acre, it appears that the erratic results were due to ineffective application. Possibly unfavorable factors of weather, as yet not fully appreciated or understood, were responsible for the ineffective application of the sprays in most of the tests. Essentially the same type of spray dispensing equipment was used in all tests discussed in this report, which makes it appear that "weather" was the cause of the erratic results. However, some of the spraying that proved ineffective was done under weather conditions which were deemed at the time to be suitable for spraying.

On the basis of the tests reported here the following tentative conclusions are drawn:

1. A dosage of 1 pound of DDT in 1 gallon of spray per acre is sufficient to control this sawfly if properly applied under favorable conditions, and 1/2 pound may be ample, especially if the larvae are not beyond the 4th instar.

2. The boom and nozzle type of spray dispensing apparatus used gave satisfactory distribution of the spray when the spraying was done under favorable conditions.

3. Possibly the relatively low temperatures at the time of spraying in early June and early November were an important factor in effecting control.